DOCUMENT RESUME

ED 243 276 EC 162 181

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TITLE The Memory-Metamemory Connection in Retarded and Nonretarded Students.
PUB DATE Aug 83
NOTE 40p.; Paper presented at the Annual Convention of the American Psychological Association (91st, Anaheim, CA, August, 1983).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Memory; *Mental Age; *Metacognition; *Mild Mental Retardation; *Recall (Psychology)

ABSTRACT

Twenty mildly mentally retarded students were matched with two groups of normal students, one of the same chronological age (CA) and one of the same mental age (MA), to examine the influence of age indices and metamemory on memory behavior in terms of recall accuracy and recall time. This was achieved using a metamemory instrument which was adapted for use with the retarded sample and included relevant recall tasks. Results of specific reponses showed group differences when the nature of each question and the degree of sensitivity required to repond to it were considered. Recall accuracy measures showed that when tasks exhibited some organisational features, the retarded group was as accurate as the CA counterparts; when recall tasks were less organised, they responded much like their mental age counterparts. In terms of recall time, the CA matched group responded significantly faster than the MA matched group and retarded students on all tasks. Regression analyses on recall accuracy showed that depending on task characteristics, chronological age emerged as a significant predictor of recall in certain situations, and in others, mental age was a superior predictor. Metamemory reponses in two tasks accounted for more variance than either CA or MA. Regression analyses on recall time indicated that MA was the single most powerful predictor here. (Author/CL)

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ED243276

# The Memory-Metamemory Connection in Retarded and Nonretarded Students

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Submitted for Presentation
to the
91st Annual Convention
of the
American Psychological Association
at
Anaheim, CA, August 1983

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Mentally retarded students were matched with two groups of normal students, one chronological age and one mental age, respectively, to examine the influence of age indices and metamemory on memory behaviour in terms of recall accuracy and recall time. This was achieved using a metamemory instrument which was adapted for use with the retarded sample and included relevant recall tasks.

Results of specific responses showed group differences when the nature of each question and the degree of sensitivity required to respond to it were considered.

Recall accuracy measures showed that when tasks exhibited some organisational features, the retarded group was as accurate as the CA counterparts; when recall tasks were less organised, they responded much like their mental age counterparts. In terms of recall time, the CA matched group responded significantly faster than the MA matched group and retarded students on all tasks.

Regression analyses on recall accuracy showed that depending on task characteristics, chronological age emerged as a significant predictor of recall in certain situations and in others, mental age was a superior predictor. Metamemory responses in two tasks accounted for more variance than either CA or MA. Regression analyses on recall time indicated that MA was the single most powerful predictor here.

These findings are discussed in light of issues regarding the metamemory-memory behaviour relationship and its possible pragmatic extensions.

## Introduction

The concept of metamemory, viz., the knowledge one has about one's memory processes (Flavell & Wellman, 1977) has received fairly extensive attention in the child development literature. Extending the study to exceptional individuals, in particular the mentally retarded, we find to date, two major perspectives. The first is represented by demonstration studies, showing retarded-nonretarded differences in metamorial situations (Blackman et al., Catino, 1976; Denny, 1974). These have, for the most part indicated that mentally retarded students are less efficient than their nonretarded counterparts in making accurate predictions about their memory. The other perspective has taken the training approach, conducted by Ann Brown and her colleagues. A series of studies have generally demonstrated that older mentally retarded individuals are more responsive to training efforts than are younger mentally retarded persons, in that the former group is better able to maintain and generalise the strategies over time (Brown & Barclay, 1976; Brown & Campione, 1977; Brown et al., 1977).

Few studies have examined the potential connection between knowledge and behaviour, i.e. metamemory and memory use, and the complexity of these patterns has been documented by several investigators (Flavell & Wellman, 1977; Lawson, 1980; Ritter, 1976; Wellman, 1977; Wellman et al., 1975). Perhaps Brown's attempt (1978) and Eyde and Altman's study (1978) are the only two reported pieces of evidence where the relationship in mentally retarded populations has been explored. However, both reports were somewhat limited by the constraints of inadequate task sampling and methodology respectively, so much so, that their results fail to be compelling.

The present study was an attempt in overcoming the above limitations

by (a) selecting metamemory situations that are most relevant to a school curriculum and (b) designing performance tasks that are closely related to the selected metamemory situations. The following questions were examined:-

1. How do retarded and nonretarded students compare on their responses to a metamemory interview?
2. How do the groups compare on their recall in memory tasks?
3. What is the contribution of CA, MA and metamemory, to the explained variance in memory tasks?

## Method

### Subjects

A total of 60 subjects, consisting of three groups of 20 each were employed to participate in the study. They were sleected from public schools and to comply with the following characteristics:-

1. A group of 20 EMR students from special education classes, of $\overline{IQ}$ 65, $\overline{CA}$ 15 and $\overline{MA}$ 9.8 years.
2. A group of 20 regular class students of $\overline{IQ}$ 100, $\overline{CA}$ 15.2 and $\overline{MA}$ 16.1 years.
3. A group of 20 regular class students of $\overline{IQ}$ 100, $\overline{CA}$ 9.1 and $\overline{MA}$ 9.5 years.

Groups 2 and 3 were selected to serve as CA and MA matches for the EMR group.

Table 1 about here

### Instrument

In order to assess metamemory, Kreutzer et al.'s questionnaire (1975) was considerably adapted for use in the present investigation. Of the

original 14 subtests, four were selected here on the basis of their relevance to the cognitive demands of school-related activities. They were (1) Memory Ability (2) Story vs. List (3) Study Time and (4) Study Plan. Each of these situations comprised four questions, to which responses could be given as any one of a three-response forced choice format. Each metamemory subtest was followed by specific memory tasks, designed to examine recall in the metamorial situation that preceded it. Each of the first three subtests was followed by two recall tasks, while the fourth subtest was followed by one. The first of each pair of memory tasks presented subjects with little or no inherent organisation, while the second in each pair contained items (or instructions) that facilitated organisational strategies by the respondents.

Design and Procedure

Each subject was individually interviewed in two sessions. In all groups, subjects received two metamemory subtests and their accompanying memory tasks in one session. The remaining two subtests and relevant recall tasks were administered in the second session.

The four parts of a typical protocol (each part consisting of a metamemory subtest and its recall tasks) were assembled in a randomised latin square ordering, such that in all groups, each part appeared in each ordinal position an equal number of times.

During the first session, each subject was told that the purpose of the interview was to find out what school children know about their memory. They were assured that the interview was not a test of expertise and that there were no right or wrong answers. In the metamemory section, subjects were encouraged to respond in terms of one of the three response choices that

were orally presented by the experimenter. Adaptations in the wording of questions were made to make the situations age-appropriate. The metamemory responses were scored on protocols during the interview. Actual recall information was elicited with the use of a tape recorder and transcribed to the protocols at a later time. Time allotted for study in the recall tasks and that taken to give recall from the subjects was monitored with a stop-watch.

## Results

In this and the following sections, all references to the three subjects groups will be made as follows: the CA group refers to the 15-year old, non-retarded sample, the MA group refers to the 9-year old nonretarded sample and the MR group refers to the mentally retarded sample.

### Metamemory Questions

Responses to the metamemory section for all three groups were analysed in chi-square contingency tables. A post-hoc technique for examining response patterns, called partitioning of chi-square tables was undertaken to reveal where the group differences lie (Bresnahan & Shapiro, 1966).

Table 2 about here

Significant differences occurred when specific responses were analysed. Firstly, subjects appeared to utilise their prior experiences in the response choices they made. Under the Story vs. List subtest, in response to the question, "What is the best way to remember other words like these?", that 80% of the CA group claimed that another story context would be helpful, suggested that this group may have had a richer set of experiences where

remembering via a semantic context was known to enhance recall. Conversely, only 35% of the MR group responded in the same manner, while 40% of them claimed that repeating the words would be the best way. In applying the situation to themselves, the MR group may have been exposed to situations where repetition, more typically is the spontaneous mode of study (Cole & Scribner, 1977).

In the same vein, with reference to the Study Plan subtest, the question, "Do you remember how you came to study this way?" generated the clearest group differentiation in terms of response selection. Here again, that 60% of the CA group indicated that they themselves arrived at their preferred mode of remembering conceptually related items, was indicative of their own set of experiences. The CA group at 15 years of age has probably encountered most of the demands of formal schooling in a variety of academic situations. The MA group at 9 years of age has experienced comparatively fewer occasions in which to experiment with different methods of study. Further, this may well be bound to their poorer recollection of how they learned to study in a particular manner, and consequently they may have been less able to articulate the developmental history of the memory strategy in question. The MR group, though attending public school, may in all probability have had a qualitatively different set of experiences in certain academic situations. With the thrust of special education and associated teacher expectations, retarded students may be taught certain study habits. While such instruction is not typically systematic, some mention may be made of the dynamic of outer-directedness, as a motivational response pattern among mentally retarded learners (Zigler, 1968). Zigler and cohorts argue that due to the inordinate amount of failure that the retarded child experiences when relying on his/her own resources, these individuals tend typically to seek assistance from significant others

in their environment. Therefore, it is reasonable to assume that in response to the metamemory question, "Do you remember how you came to learn this way?", most of the MR group (50%) claimed that someone had taught them.

The second observation concerning response choices made by the three groups, was that the groups were generally consistent with the quality of response selection across all questions. With reference to Table 2, it will be recognised that response choices to each question were ordered on a continuum, ranging from the least to the most appropriate/correct response. The MR group was most consistent in indicating that more time facilitated recall and was also aware of the subtle distinction between having more time to study and being good at remembering. On the other hand, the MA group indicated some preference for more study time, but did not recognise the above distinction. Similar distinctions between groups emerged for the Story vs. List and Study Plan subtests.

Group differences that emerged in the metamemory section showed that both chronological age and quality of experience interacted in a pattern of metamemory responses elicited by the subjects. All subjects had a general awareness of the metamemorial demands of each of the four situations. However, an analysis of specific questions indicated that different degrees of sensitivity were necessary to make adequate response choices. On some questions the CA and MR groups behaved similarly, both being different from the MA group. These responses suggest that a chronological age factor might be operative here. On the other items, the CA and MA groups were more similar in response choice, pointing thereby to differential experiences between them and the MR group.

Such a finding is difficult to reconcile with what has been reported

in the literature. Firstly, comparative studies of this nature have employed only MA matched groups. These examined metamemory in normal kindergarten (MA 6) and normal third graders (MA 8), who served as matches for educable groups of comparable mental ages (Brown, 1978). Results showed that at MA 8, 80% of the educable subjects made adequate response choices, while 100% third graders were able to do so. By contrast, in the present study, 90-95% of educable subjects were able to make adequate responses to the same subtests used in Brown's study. Secondly, the present study used a wider range of metamemory situations and older subjects (MA $>$ 8), so that direct comparisons with the sparse number of documented studies, becomes difficult. It does appear however, that metamemorial sensitivity, in a developmental sense improves with age. Nonetheless, the effect of chronological age may be tempered by the quality of experience.

Recall Tasks

In order to compare the three groups' recall on the memory tasks, both recall accuracy (number of items correctly recalled) and recall time (time taken to give recall) were examined.

Recall Accuracy

Table 3 (a) shows multivariate F ratios for recall accuracy. All analyses yielded significant differences.

Table 3 (a) about here

Post-hoc comparisons were investigated following two statistical routes:-

1. Univariate analysis of variance indicated that the three subject groups were significantly different on several tasks.

Table 3 (b) and Table 3 (c) about here

The MR group recalled as much as their CA counterparts when tasks were

organised and when time was generous. Initial group differences in task 1, task 3 and task 5 disappeared in task 2, task 4 and task 6. While the MR and the MA groups' recall was not significantly different in tasks 1, 3, 4 and 5, large differences emerged in task 2 and task 6, where the MR group benefitted from the facilitating effects of task conditions. CA vs. MA group differences persisted in all the last task (ceiling effects were obtained here), showing that nonretarded 15-year olds were superior to nonretarded 9-year olds in recall under all conditions, but the last task.

These findings are in contrast to what has typically been reported in the memory literature. As was described earlier, most studies have employed only MA matched groups against whose performance the MR group's recall is evaluated. These have repeatedly shown that only under conditions of explicit training in rehearsal strategy use, do MR groups' recall improve, and that too, only as much as their MA counterparts (Borkowski & Wanschura; 1974; Turnbull, 1974). The present study made no attempt to instruct subjects in the use of memory strategies; task instructions merely described the nature of the task at hand. Yet under conditions where the to-be-remembered items contained potentially organisational features, the MR group achieved substantial gains in recall.

2. Discriminant Analysis

Table 4 (a) shows in terms of recall accuracy, two discriminant functions were extracted to separate the three groups on the seven recall tasks.

Table 4 (a) & (b) about here

Changes in task demand appeared to define the three groups, with the MR group behaving like their CA counterparts when task organisational features were present. The weighting patterns of the standardised discriminant weights on one function were different from that on the other. Group centroids represent-

ed in two-dimensional space showed that on one function the CA and MR groups were alike, while on function 2, the CA and MA groups were similar.

Figure (c) of Table 4 about here

Item Clustering

A common feature to tasks 2 and 7 was that they both consisted of items that were potentially clusterable (they did differ in task instruction, however). In order to examine whether subjects employed an organisational strategy to mediate recall, an item clustering index (Bousfield and Bousfield, 1966) was computed for the recall on each of these two tasks. This index was correlated with total recall on these two tasks to determine if item clustering was related to recall accuracy (see Appendix 1). Within the CA group, correlations between item clustering and recall on task 2 and on task 7 were both significant (0.60 and 0.51, respectively). For the MR group, a significant correlation was obtained on task 2 (0.52) but not on task 7 (0.47). In the MA group, neither correlations was significant. There were no significant differences in these correlations between groups, indicating that in no group did the utilisation of item clustering relate more strongly to the number of recalled items.

These observations are relevant to the production versus structural deficiency hypothesis in attempting to define differences between retarded and nonretarded learners. This view holds that retarded persons differ from nonretarded persons in that they do not spontaneously employ the necessary rehearsal mechanisims, resulting in differential recall between the two groups (Belmont & Butterfield, 1971; Brown, et al, 1974; Brown & Lawton, 1977; Ellis, 1970). The present investigation suggests that retarded persons may be capable of generating rehearsal mechanisms if task conditions exhibit certain organisational features. Explicit training procedures were not necessary to encourage

retarded students to recognise and use these characteristics profitably; task instructions and changes in task demand seemed sufficient to improve recall. Reference to item clustering data shows that significant correlations between clustering and recall emerged for both the CA and MR groups, but not for the MA group. Accordingly, the MR group appeared as able as their CA counterparts to benefit from clustering behavior insofar as it enhanced recall.

Therefore these findings necessitate the evaluation of the production versus structural theories in a somewhat different perspective. The generalisation that retarded persons do not spontaneously initiate memory strategies may perhaps be too strong a statement. It should be attenuated to point out that inherent characteristics of the task at hand, as well as the nature of study or recall instructions, may influence the production of rehearsal mechanisims in retarded persons. The failure is still one of production, but it appears sensitive to task demand.

Recall Time

Group compasisons were made employing the analytic procedures as were used in examining recall accuracy.

Table 5 (a), (b) & (c) about here

Table 6 (a) indicates that two discriminant functions together accounted for all the variance in recall time.

Table 6 (a) & (b) about here

With reference to Figure 6 (c), the scatterplot of group location on the two discriminant functions, there was clear separation between the CA group and the other two groups on Function 1.

Figure (c) of Table 6 about here

The analysis of recall time measures produced a rather different pattern

of results. The most clear-cut finding was that in terms of time taken to recall, the CA group was far superior to the MA and MR groups. Analysis of variance showed that on all tasks, the CA group took significantly less time to respond than both the MA and MR groups. Thus when recall time is considered, the MR group behaved more like their MA counterparts and both those were significantly different from the CA group.

Attempts to relate these observations to studies in the literature run into much the same problems as were encountered for recall accuracy. Primarily, of the few studies that have employed CA comparison groups, the dependent variable of interest was reaction time, and independent measures usually involved some form of choice discrimination of the motor type (Krupski, 1977; Lally & Nettleback, 1977; Wade et al., 1978). These studies have generally shown that under task instructions that emphasised speed of response, CA groups responded the fastest, followed by MA groups and MR groups. While no attempt was made here to stress speed of response, similar patterns of group performance emerged, with the CA group responding significantly faster than the MR and MA groups.

To summarise: what defines that MR group as developmentally functioning like their MA counterparts in this study is (a) both groups' relatively poorer ability to generate their own rehearsal mechanisms efficiently, when task condition do not present organisational features, and (b) the longer time taken to complete recall. Condition (a) nonetheless, does not hold when task features exhibit inherent organisational characteristics and here, the MR group behaves very much like their CA counterparts.

Relationship between Age Indices, Metamemory and Recall

In order to examine the contribution of metamemory to recall behaviour, these responses (dummy coded) were included in multiple regression analyses, with chronological age and mental age as predictors. What subsequent pro-

portion of variance could be explained by metamemory when the effects of CA and MA were partialled out?

Table F (a) about here

There were two recall tasks on which the proportion of variance accounted for by metamemory was sizeable, viz., task 3 and task 7. In particular, on task 3, responses to Story vs. List accounted for 25% of the variance, which according to incremental F values, was significantly greater than explained by CA (0.3%) and MA (8%). This tends to indicate that much of the difference in recall here, was explained by the response pattern on Story vs. List subtest. While proportions of variance explained by metamemory on tasks 2,4 and 6 were not, in absolute terms large, their incremental F values indicated that they were significantly greater than those of MA on the same tasks. These observations may suggest that metamemory, to a lesser extent was like CA, sensitive to task demand.

Canvanaugh and Borkowski (1980) also found that age indices were on the whole more sensitive to differences in recall, and in their study CA emerged as the most powerful predictor of memory behaviour.

Regression on recall time clearly showed that based on the order of entry, MA was the single most powerful predictor of recall time.

Table 7 (b) about here

Subjects of high MA (nonretarded 15-year olds) were significantly more efficient in terms of time taken to execute recall than were the other two groups. CA did not enhance $R^2$ significantly in any of the tasks, while responses to metamemory did significantly enhance $R^2$ and $R^2$ change. This suggests that metamemory knowledge as assayed in the present investigation, contributed significantly more to differences in recall time than did CA. That CA fared so poorly in this analysis, may be attributed to the time taken by the MR group in all tasks. This delay

attenuated the mean recall time for subjects of the same CA (15-year olds and retarded subjects), resulting in MA emerging as the superior predictor of recall time.

What can be said for the pragmatic extensions of these major findings? Can some aspect of metamemory and its relationship to recall be exploited for instructional purposes?

It would seem that metamemory knowledge at the general level was, to a large extent exhibited by all subjects, including the MR group. Its connection with memory behaviour, as assessed under recall measures, suggests that in certain tasks, it may significantly be related to recall. This emerging connection does appear to be developmentally sensitive when tasks are characterised by some form of organisation, exemplified in cases where CA and metamemory both accounted for more variance thant did MA. The MR group generally exhibited metamemorial sensitivity, although when questions were inferential in nature (i.e. in extending the situation to themselves), they reverted to the selection of less efficient strategies. Clearly, instruction in these areas could beneficially be combined with actual feedback from memory recall. It is encouraging to note that the field of special education is currently witnessing the emergence of such programmes, where retarded learners' curricula are systematically combined with methodically sequenced exercises in metacognitive planning and in the analysis of problem-solving behaviour (Feuerstein, 1980).

Finally, an understanding of the status of metamemory in the regulation of memory behaviour was, in this study limited to situations that were (a) related to the intellectual demands of school activities and (b) within the cognitive repertoire of all subjects. As such, little attempt was made to examine whether strategic behaviour was in fact employed, with the exception

of item clustering indices. The major index of the influence of metamemory was in consideration of its zero-order correlations with recall and the amount of variance explained in the recall tasks. Perhaps future investigations should design their tasks such that more direct measures of strategic behaviour can be examined as additional dependent variables.

Further, it will be remembered that CA and MA as independent variables were recognised as somewhat overinclusive. It may be more conceptually useful to employ indices of certain cognitive abilities that are known to be developmentally sensitive, i.e. increase with CA and MA. In this manner, one would have a more coherent and meaningful framework in which to assess the relative importance of a set of predictors to changes in memory behaviour.

## Summary and Conclusions

The main conclusions of the investigation were that age indices and metamemory responses interacted in a pattern that showed sensitivity to task demands. All groups demonstrated an overall awareness for the situations portrayed in the metamemory section of the instrument. The retarded group behaved much like their CA nonretarded counterparts on several questions, and on others, like their MA peers. However, in terms of explained variance in recall tasks, age indices accounted for more variance on the whole than did metamemory, but here again, distinctions appeared sensitive to task demand. That on two recall tasks metamemory emerged as a superior predictor or recall, may indicate a growing connection between metamemorial knowledge and memory behaviour. These findings provide a more comprehensive view of the interaction between memory and metamemory processes in retarded popu-

lations than has been hitherto reported. Implications of these results suggest that retarded students do exhibit some level of metamnemonic awareness and that in certain task situations, when combined with feedback from actual recall behaviour, may profit from systematic instruction in metacognitive planning activities.

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TABLE 1

Means and Standard Deviations of Ages in All Groups

| Group | N | Chronological Age | | Mental Age* | |
|---|---|---|---|---|---|
| | | $\bar{X}$ | S.D. | X | S.D. |
| CA Match | 20 | 15.2 | 1.9 | 16.1 | 2.6 |
| MA Match | 20 | 9.1 | 1.5 | 9.5 | 2.1 |
| Educable Students | 20 | 15.0 | 2.3 | 9.8 | 2.5 |

*Based on IQ's determined from Stanford-Binet Scale.

Table 2

Chi Square Analyses Across Groups on Metamemory Items

| Metamemory Subtask | # | Question | Response Category | Frequency Across Groups CA | MA | MR | Overall $X^2$ | $x^2$ Upon Partitioning CA v. MA | CA v. MR | MA v. MR |
|---|---|---|---|---|---|---|---|---|---|---|
| MEMORY ABILITY | | | | | | | | | | |
| General question regarding knowledge of one's memory | 1. | There are times when I forget. Do you forget? | Always | 0 | 1 | 2 | | | | |
| | | | Sometimes | 20 | 19 | 17 | | | | |
| | | | Never | 0 | 0 | 1 | 4.25 | 1.79 | 3.96 | 2.87 |
| | 2. | Do you remember things well. Are you a good rememberer? | Always | 1 | 3 | 2 | | | | |
| | | | Sometimes | 19 | 16 | 18 | | | | |
| | | | Never | 0 | 1 | 0 | 3.26 | 2.97 | 1.29 | 2.38 |
| | 3. | Do you remember some kinds of things better than other kinds of things? | Yes | 20 | 20 | 16 | | | | |
| | | | No | 0 | 0 | 4 | 8.57* | 2.88 | 7.19 | 7.19 |
| | 4. | Are there some kinds of things that are hard to remember? | Yes | 19 | 18 | 19 | | | | |
| | | | No | 1 | 0 | 1 | 0.53 | 0.47 | 0.00 | 0.47 |

*$p<.05$

Table 2--Continued

| Metamemory Subtask | # | Question | Response Category | Frequency Across Groups CA | MA | MR | Overall $x^2$ | $x^2$ Upon Partitioning CA v. MA | CA v. MR | MA v. MR |
|---|---|---|---|---|---|---|---|---|---|---|
| STORY v. LIST | | | | | | | | | | |
| Situation where first girl is asked to remember a set of pictures, and second girl is told a story about the pictures. | 1. | Do you think the story made it easier or harder to remember the pictures? | Easier | 20 | 18 | 18 | | | | |
| | | | Harder | 0 | 1 | 2 | | | | |
| | | | No difference | 0 | 1 | 0 | 4.14 | 2.83 | 2.80 | 2.75 |
| | 2. | Which girl remembered the most? | First girl | 0 | 1 | 1 | | | | |
| | | | Second girl | 20 | 19 | 19 | | | | |
| | | | Neither | 0 | 0 | 0 | 1.03 | 0.89 | 0.89 | 0.00 |
| | 3. | Why? | Story made it harder | 0 | 1 | 0 | | | | |
| | | | Story made it easier | 20 | 15 | 19 | | | | |
| | | | Words easy to remember without story | 0 | 4 | 1 | 7.97 | 7.31* | 2.28 | 5.76 |
| | 4. | Which is the best way to remember other words like these? | Look at them | 0 | 2 | 5 | | | | |
| | | | Through another story | 16 | 9 | 7 | | | | |
| | | | Repeat them | 4 | 9 | 8 | 11.62* | 2.08 | 8.19* | 0.72 |

*$p < .05$

Table 2--Continued

| Metamemory Subtask | # | Question | Response Category | Frequency Across Groups CA | MA | MR | Overall $X^2$ | $X^2$ Upon Partitioning CA v. MA | CA v. MR | MA v. MR |
|---|---|---|---|---|---|---|---|---|---|---|
| STUDY TIME | | | | | | | | | | |
| Situation where one student is asked to study 20 pictures in 1 minute, and another is asked to study them in 5 minutes | 1. | Which student remembered the most? | Same for both | 2 | 2 | 0 | | | | |
| | | | One who studied 5 minutes | 13 | 16 | 20 | | | | |
| | | | One who studied 1 minute | 5 | 2 | 0 | 8.94 | 4.50 | 8.58* | 4.90 |
| | 2. | Why? | One smarter | 5 | 2 | 0 | | | | |
| | | | More time is helpful | 13 | 15 | 20 | | | | |
| | | | List can be remembered in 1 or 5 minutes | 2 | 3 | 0 | 9.85* | 4.86 | 8.69* | 6.17* |
| | 3. | Which would be better for you: 1 minute or 5 minutes? | 1 minute | 3 | 3 | 3 | | | | |
| | | | 5 minutes | 14 | 15 | 14 | | | | |
| | | | No difference | 3 | 2 | 3 | 0.29 | 0.26 | 0.00 | 0.26 |
| | 4. | Which would you choose: to have more time to study or to be really good at remembering? | Both same | 0 | 3 | 0 | | | | |
| | | | Good at remembering | 14 | 10 | 11 | | | | |
| | | | More time | 6 | 6 | 9 | 7.37 | 5.97* | 3.19 | 5.73 |

*p<.05

Table 2--Continued

| Metamemory Subtask | # | Question | Response Category | Frequency Across Groups CA | MA | MR | Overall $x^2$ | $x^2$ Upon Partitioning CA v. MA | CA v. MR | MA v. MR |
|---|---|---|---|---|---|---|---|---|---|---|
| STUDY PLAN | | | | | | | | | | |
| Situation in which subjects are shown nine clusterable pictures, told they can do anything with the pictures that would help them remember. | 1. | What would be the best way to learn these pictures? | Look at them | 1 | 2 | 5 | | | | |
| | | | Group them | 18 | 14 | 15 | | | | |
| | | | Repeat names | 1 | 4 | 0 | 9.00 | 5.24 | 5.36 | 7.29* |
| | 2. | Do you remember how you came to learn this way? | Don't remember | 2 | 11 | 6 | | | | |
| | | | Tried many ways, figured this was best | 12 | 4 | 4 | | | | |
| | | | Someone taught me | 6 | 5 | 10 | 14.82* | 12.44* | 9.72* | 7.47* |
| | 3. | How would someone who is 6 years old remember these pictures? | Different way | 14 | 17 | 11 | | | | |
| | | | Same as me | 4 | 1 | 7 | | | | |
| | | | Wouldn't remember at all | 2 | 2 | 2 | 5.78 | 2.89 | 2.89 | 5.78 |
| | 4. | Can you use this way remembering for the kinds of things you need to remember in class? | Some things | 20 | 18 | 11 | | | | |
| | | | All things | 0 | 2 | 8 | | | | |
| | | | None | 0 | 0 | 1 | 15.13* | 5.54 | 14.16 | 10.70* |

*p<.05

TABLE IIIa

Multivariate F Ratios for Paired Groups on Recall Accuracy

| Groups | df | F |
|---|---|---|
| CA v. MR | 7,51 | 4.21* |
| CA v. MA | 7,51 | 8.58* |
| MA v. MR | 7,51 | 5.09* |

*p < .05

TABLE IIIb

Univariate F Ratios for Paired Groups on Recall Accuracy

| Task | CA v. MR | CA v. MA | MA v. MR |
|---|---|---|---|
| 1. Free recall of 12 unrelated pictures, randomly presented for 3 minutes | 19.04* | 34.21* | 2.21 |
| 2. Free recall of 12 clusterable items, randomly presented for 3 minutes | 0.73 | 39.84* | 29.77* |
| 3. Free recall of seven unrelated pictures, serially presented and removed | 4.64* | 4.05* | 0.02 |
| 4. Free recall of seven pictures serially presented within a story context and removed. | 2.63 | 7.73* | 1.34 |
| 5. Free recall of 20 unrelated pictures, randomly presented for 1 minute | 10.22* | 19.93* | 1.61 |
| 6. Free recall of the above 20 unrelated pictures, presented for 5 minutes | 2.01 | 19.49* | 8.99* |
| 7. Free recall of nine clusterable pictures, randomly presented for 3 minutes. Subject encouraged to organise. | 1.53 | 2.71 | 0.17 |

df = 1,57, *p < .05

TABLE IIIc

Mean Recall Accuracy by Group

| Group | Task 1 (12) | Task 2 (12) | Task 3 (7) | Task 4 (7) | Task 5 (20) | Task 6 (20) | Task 7 (9) |
|---|---|---|---|---|---|---|---|
| CA | 10.25 | 11.25 | 5.10 | 6.70 | 10.10 | 15.55 | 8.90 |
| MR | 7.90 | 10.85 | 4.35 | 6.35 | 7.45 | 14.25 | 8.60 |
| MA | 7.10 | 8.30 | 4.40 | 6.10 | 6.40 | 11.50 | 8.50 |

( ) Total possible score.

TABLE IVa

Discriminant Analysis

Recall Accuracy

Canonical Discriminant Functions

| Function | % of Variance | After Function Removed | Wilks' λ | Chi Square | df | p < |
|---|---|---|---|---|---|---|
| 1 | 73.62 | 0 | 0.34 | 60.61 | 8 | 0.00 |
| 2 | 26.38 | 1 | 0.71 | 18.79 | 3 | 0.00 |

TABLE IVb

Discriminant Analysis

Recall Accuracy

Standardised Discriminant Function Weights

(based on the four significant variables)

| Variable (Recall Task) | Function 1 | Function 2 |
|---|---|---|
| Free recall of 12 unrelated pictures randomly exposed for 3 minutes | 0.57 | 0.59 |
| Free recall of 12 clusterable items, randomly presented for 3 minutes | 0.56 | -1.01 |
| Free recall of seven unrelated pictures, serially presented and removed | -0.20 | 0.34 |
| Free recall of 20 unrelated pictures, randomly presented for 1 minute | 0.33 | 0.56 |

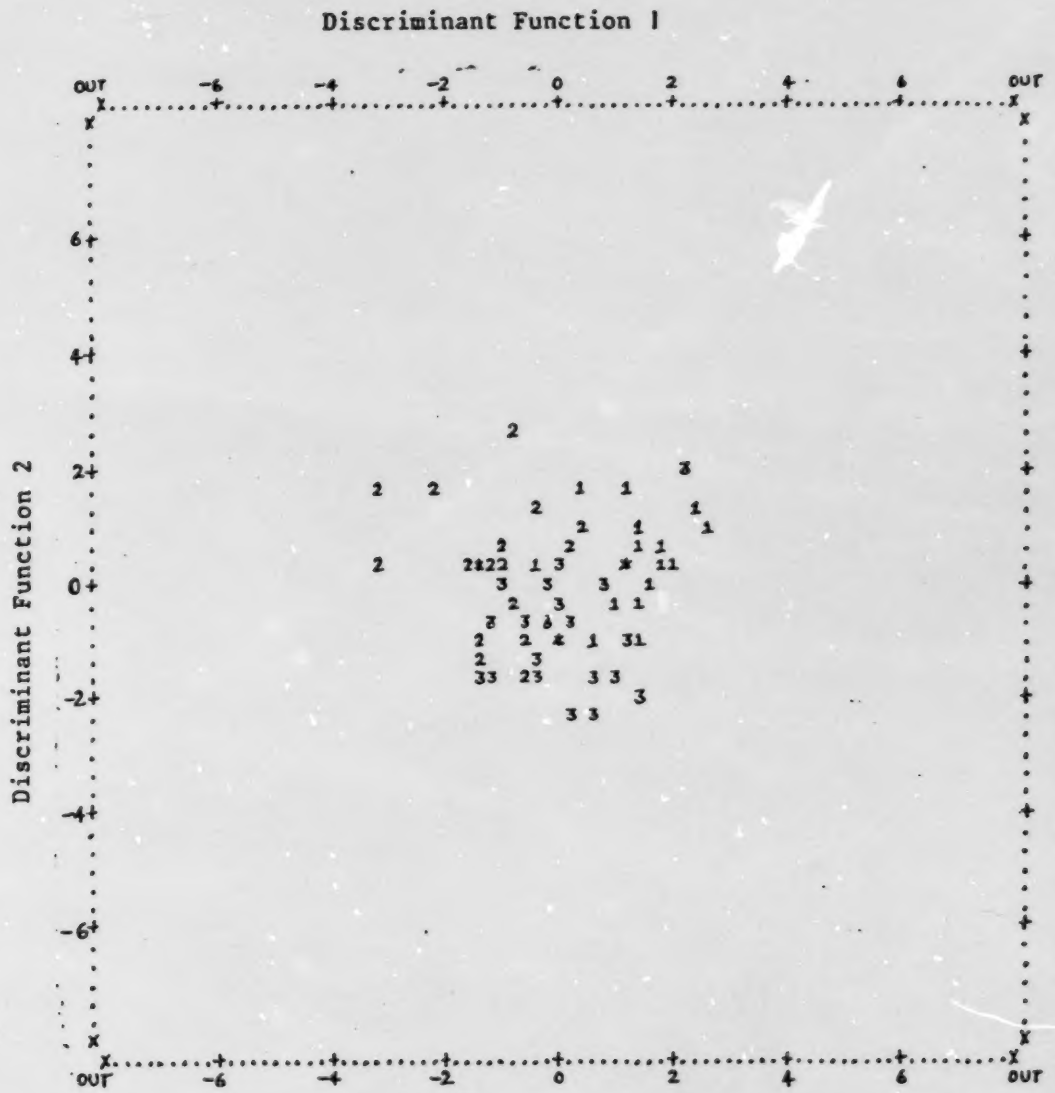


Figure c of Table 4. Scatterplot of Groups on Discriminant Dimensions: Recall Accuracy

1 = CA group, 2 = MA group, 3 = MR group,
* = group centroid (mean)

Discriminant Functions Evaluated at Group Centroids (*)

| Group | Function 1 | Function 2 |
|---|---|---|
| 1 | 1.22 | 0.48 |
| 2 | -1.31 | 0.39 |
| 3 | 0.08 | -0.87 |

TABLE Va

Multivariate F Ratios for Paired Groups on Recall Time

| Groups | df | F |
|---|---|---|
| CA v. MR | 7,51 | 57.61* |
| CA v. MA | 7,51 | 54.16* |
| MA v. MR | 7,51 | 1.25 |

*p < .05

TABLE Vb

Univariate F Ratios for Paired Groups on Recall Time

| Task | CA v. MR | CA v. MA | MA v. MR |
|---|---|---|---|
| 1. Free recall of 12 unrelated pictures, randomly presented for 3 minutes | 217.98* | 198.61* | 0.45 |
| 2. Free recall of 12 clusterable items, randomly presented for 3 minutes | 161.76* | 143.29* | 0.55 |
| 3. Free recall of seven unrelated pictures, serially presented and removed | 228.44* | 213.94* | 0.23 |
| 4. Free recall of seven pictures, serially presented within a story context | 136.33* | 83.12* | 6.54* |
| 5. Free recall of 20 unrelated pictures, randomly presented for 1 minute | 87.05* | 85.17* | 0.01 |
| 6. Free recall of above 20 pictures, presented for 5 minutes | 63.97* | 62.15* | 0.01 |
| 7. Free recall of nine clusterable pictures, randomly presented for 3 minutes. Subjects encouraged to organise | 57.78* | 49.82* | 0.29 |

df = 1, 57, *p < .05

TABLE Vc

Mean Recall Time by Group (secs.)

| Group | Task 1 | Task 2 | Task 3 | Task 4 | Task 5 | Task 6 | Task 7 |
|---|---|---|---|---|---|---|---|
| CA | 15.55 | 10.95 | 10.20 | 7.30 | 22.60 | 17.90 | 9.05 |
| MR | 21.05 | 16.05 | 14.85 | 10.95 | 27.20 | 21.40 | 11.15 |
| MA | 20.80 | 15.75 | 14.70 | 10.15 | 27.15 | 21.35 | 11.00 |

TABLE VIa

Discriminant Analyses

Recall Time

Canonical Discriminant Functions

| Function | % of Variance | After Function Removed | Wilks' $\lambda$ | Chi Square | df | p < |
|---|---|---|---|---|---|---|
| 1 | 98.46 | 0 | 0.08 | 140.16 | 10 | 0.00 |
| 2 | 1.54 | 1 | 0.86 | 8.04 | 4 | 0.09 |

TABLE VIb

Discriminant Analyses

Recall Time

Standardised Discriminant Function Weights

(based on the five significant variables)

| Variable (time taken to give) | Function 1 | Function 2 |
|---|---|---|
| Free recall of 12 unrelated pictures, randomly exposed for 3 minutes | 0.56 | -0.10 |
| Free recall of seven unrelated pictures, serially presented and removed | 0.55 | -0.72 |
| Free recall of seven pictures, serially presented within a story context | -0.05 | 1.30 |
| Free recall of 20 unrelated pictures, randomly presented for 1 minute | 0.26 | -0.33 |
| Free recall of nine clusterable pictures, randomly presented for 3 minutes. Subject encouraged to organise | 0.35 | 0.22 |

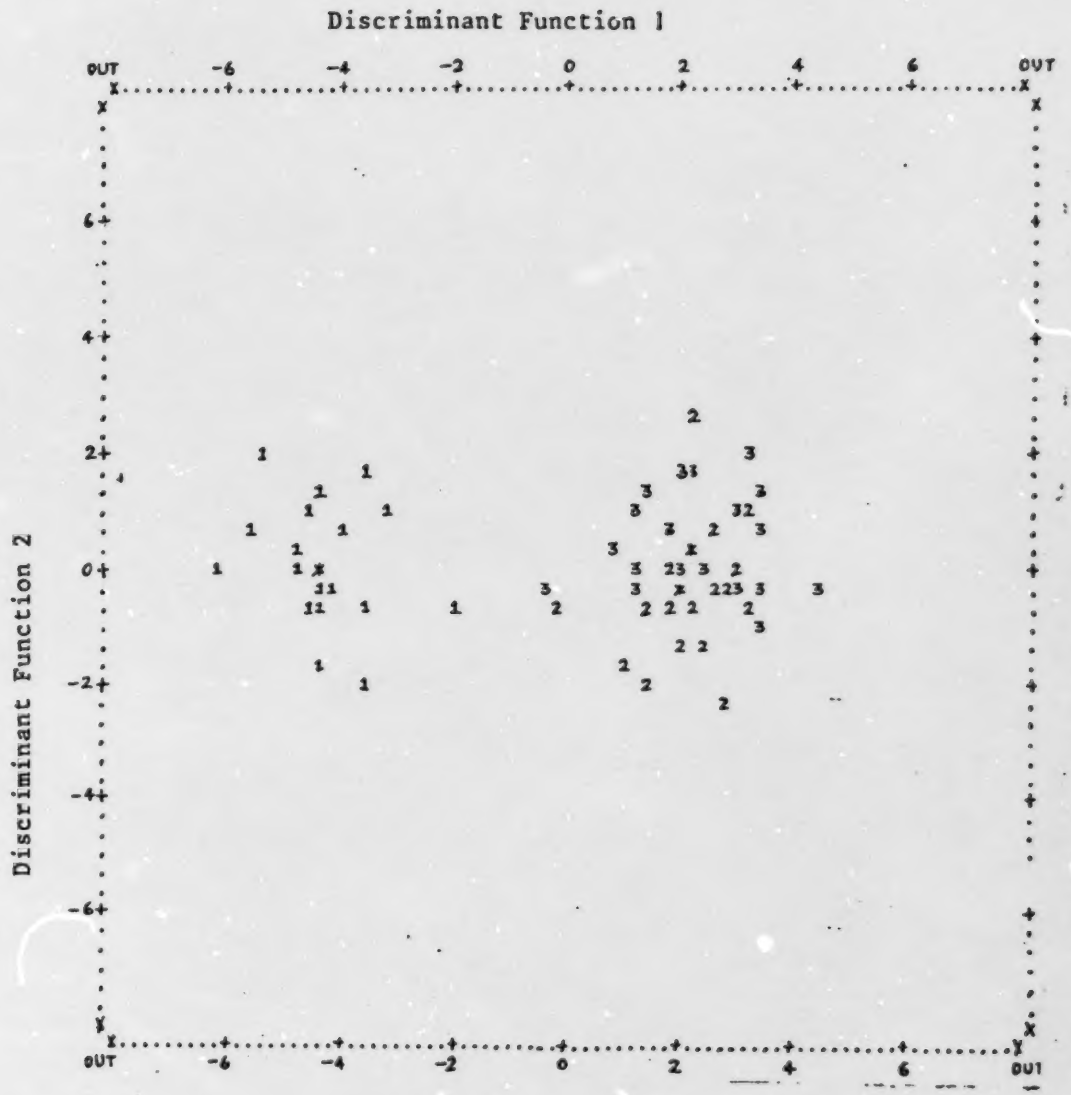


Figure c of Table 6. Scatterplot of Groups on Discriminant Dimensions: Recall Time

1 = CA group, 2 = MA group, 3 = MR group,
* = group centroid (mean)

Discriminant Functions Evaluated at Group Centroids (*)

| Group | Function 1 | Function 2 |
|---|---|---|
| 1 | -4.37 | 0.02 |
| 2 | 2.07 | -0.48 |
| 3 | 2.30 | 0.47 |

TABLE VIIa

The Contribution of Chronological Age (CA), Mental Age (MA) and Metamemory Subtests to the Explained Variance in Recall Accuracy shown via Multiple Regression Analyses

| | Criterion Variable (Recall Task) | Predictor Variables in order of entry | Multiple R | Simple R | $R^2$ (%) | $R^2$ change (%) |
|---|---|---|---|---|---|---|
| 1. | Free recall of 12 unrelated pictures, randomly presented for 3 minutes | CA | .39* | .39* | 15 | 15 |
| | | MA | .59* | .57* | 35 | 20 |
| | | θ Memory Ability | .62* | .20 | 39 | 4 |
| 2. | Free recall of 12 clusterable items, randomly presented for 3 minutes | CA | .64* | .64* | 41 | 41 |
| | | MA | .65* | .38* | 42 | 1 |
| | | θ Memory Ability | .71* | .30* | 51 | 9 |
| 3. | Free recall of seven unrelated pictures, serially presented and removed | CA | .06 | .06 | 0.3 | 0.3 |
| | | MA | .27* | .26* | 8 | 8 |
| | | θ Story v. List | .57* | .51* | 33 | 25 |
| 4. | Free recall of seven pictures serially presented within a story context | CA | .28* | .28* | 8 | 8 |
| | | MA | .36* | .33* | 13 | 5 |
| | | θ Story v. List | .47* | .30* | 22 | 9 |

θ = Metamemory Subtests each consisting of four questions.
CA = Actual Chronological Age
MA = Actual Mental Age
*$p < .05$

TABLE VIIa—Continued

| | Criterion Variable (Recall Task) | Predictor Variables in order of entry | Multiple R | Simple R | $R^2$ (%) | $R^2$ Change (%) |
|---|---|---|---|---|---|---|
| 5. | Free recall of 20 unrelated pictures, randomly presented for 1 minute. | CA | .38* | .38* | 14 | 14 |
| | | MA | .55* | .52* | 29 | 15 |
| | | θ Study Time | .62* | .29* | 38 | 9 |
| 6. | Free recall of the above 20 pictures, presented for 5 minutes | CA | .49* | .49* | 24 | 24 |
| | | MA | .52* | .40* | 27 | 3 |
| | | θ Study Time | .60* | .29* | 36 | 9 |
| 7. | Free recall of nine clusterable pictures, randomly presented for 3 minutes. Subjects encouraged to organise | CA | .12 | .12 | 1 | 1 |
| | | MA | .21 | .20 | 4 | 3 |
| | | θ Study Plan | .48* | .43* | 23 | 19 |

θ = Metamemory Subtests each consisting of four questions.
CA = Actual Chronological Age
MA = Actual Mental Age
*$p < .05$

TABLE VIIIb

The Contribution of Chronological Age (CA), Mental Age (MA) and Metamemory Subtests to the Explained Variance in Recall Time Shown via Multiple Regression Analysis

| Criterion Variable (Task) Time Taken to: | Predictor Variables in order of entry | Multiple R | Simple R | $R^2$ % | $R^2$ Change % |
|---|---|---|---|---|---|
| 1. Free recall of 12 unrelated pictures, randomly presented for 3 minutes | MA | .87* | -.87* | 76 | 76 |
| | CA | .87* | -.39* | 76 | 0 |
| | θ Memory Ability | .89* | .16 | 79 | 3 |
| 2. Free recall of 12 clusterable items, randomly presented for 3 minutes | MA | .86* | -.86* | 74 | 74 |
| | CA | .86* | -.37* | 74 | 0 |
| | θ Memory Ability | .88* | .18 | 78 | 4 |
| 3. Free recall of seven unrelated pictures, serially presented and removed. | MA | .88* | -.88* | 77 | 77 |
| | CA | .88* | -.40* | 77 | 0 |
| | θ Story vs. List | .89* | .11 | 78 | 1 |
| 4. Free recall of seven pictures, serially presented in a story context. | MA | .80* | -.80* | 64 | 64 |
| | CA | .81* | -.25 | 65 | 1 |
| | θ Story vs. List | .82* | .16 | 68 | 3 |

CA = Actual Chronological Age
MA = Actual Mental Age
θ = Metamemory Subtests, each consisting of four questions.
*$p < .05$

TABLE VIIIb--Continued

| Criterion Variable (Task) Time Taken to: | in order of entry | Multiple R | Simple R | $R^2$ % | $R^2$ Change % |
|---|---|---|---|---|---|
| 5. Free recall of 20 unrelated pictures, randomly exposed for 1 minute | MA | .80* | -.80* | 63 | 63 |
| | CA | .80* | -.38* | 63 | 0 |
| | θ Study Time | .82* | -.21 | 68 | 5 |
| 6. Free recall of above 20 pictures, randomly exposed for 5 minutes | MA | .74* | -.74* | 54 | 54 |
| | CA | .74* | -.35* | 54 | 0 |
| | θ Study Time | .81* | -.34* | 65 | 11 |
| 7. Free recall of nine clusterable pictures, randomly presented for 3 minutes. Subjects encouraged to organise | MA | .75* | -.75* | 56 | 56 |
| | CA | .75* | -.31* | 56 | 0 |
| | θ Study Plan | .81* | -.29* | 65 | 9 |

CA = Actual Chronological Age
MA = Actual Mental Age
θ = Metamemory Subtests each consisting of four questions
*$p < .05$

APPENDIX 1: CORRELATIONS BETWEEN RECALL ACCURACY AND ITEM CLUSTERING (IC)

(a) CA Group

| | | | |
|---|---|---|---|
| Task 2 | .60* | Task 7 | .51* |

(b) MA Group

| | | | |
|---|---|---|---|
| Task 2 | .48 | Task 7 | .45 |

(c) MR Group

| | | | |
|---|---|---|---|
| Task 2 | .52* | Task 7 | .47 |

(d) Overall

| | | | |
|---|---|---|---|
| Task 2 | .54* | Task 7 | .48* |

*$p < .05$